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(54) Bakery Shortening Substitute, Bakery Products Containing the Same, and Preparation Method

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BAKERY SHORTENING SUBSTITUTE, BAKERY PRODUCTS CONTAINING THE SAME, AND PREPARATION METHOD

Background of the Invention

Field of the Invention

The invention relates to a bakery shortening substitute that is an emulsion having a lipid phase and an aqueous phase, the aqueous phase containing a gelling agent that is konjac. The invention also relates to the emulsion preparation method and bakery products that contain the emulsion as a reduced-fat shortening substitute.

Background Information

A recent trend in the food industry is the introduction of reduced fat or no fat versions of many fat-containing food products, such as bakery goods. Bakery food products include cakes, cookies, pastries, breads, and the like. Baked goods are prepared from batters or doughs that contain, in addition to flour and sugar, lipids such as fats and/or oils, *i.e.*, liquid fats, often in combination with emulsifiers. Many bakery products require a relatively large proportion of fat, *e.g.*, introduced as shortening and/or butter or the like. Cake batter, for example, can contain 20-35 weight % shortening.

Elimination or replacement of a portion of the fat content in bakery food products can lead to dramatic reductions in fat content, but such reduced fat levels often have adverse consequences affecting the taste, texture and volume of the baked goods.

The functions of the fat component in bakery goods are several:

- provide shortened or flaky crumb structure;
- provide moistness and lubricity
- stabilize foam (aeration) formed during baking
- provide firmness and clean bite
- reduce product stickiness during the baking process.

Satisfactory systems for replacing the fat component in baked goods must not only be functional, *e.g.*, providing shortened crumb structure and foam stabilization,

while still providing the processing characteristics of the high fat shortenings that it replaces.

Emulsion technology has been utilized to make lowered fat food products. U.S. Patent 5,178,897 issued to Tanaka *et al.* describes a water-in-oil emulsion composition for baked food products, white bread being exemplified. The emulsion contains a sizing agent that may be starch, guar gum, carrageenan, alginates or pectin. U.S. Patent 5,332,595 issued to Gaonkar describes water/oil/water and oil/water/oil emulsions that are useful in salad dressings, spreads, sauces, frozen desserts and the like. The emulsion contains a gel forming composition that may be a gellable polysaccharide such as alginate, carrageenan, chitosan or gellan that is present as a gelatinous layer at the internal water/oil interface. The internal aqueous phase may also contain a thickener gum such as xanthan, gum arabic, carob bean gum, gum tragacanth, guar gum or the like. U.S. Patent 5,338,561 issued to Campbell *et al.* describes a water continuous emulsion that contains a gelling polysaccharide like guar, carrageenan, pectin, alginate, gellan and furcellaran, for use in nondairy creams, dressings and mayonnaises.

Konjac glucomannan is another hydrocolloid gel that has been mentioned in publications that describe its use as a thickener or gelling agent in various food applications.

U.S. Patent 4,427,704 issued to Cheney *et al.* describes thermo-reversible or thermo-irreversible gels containing carrageenan and a glucomannan such as konjac, and the thermo-irreversible gels are described as useful in food products resistant to structural breakdown upon heating.

U.S. Patent 4,582,714 issued to Ford *et al.* describes ungelled processed food product stabilized and/or thickened by at least one glucomannan, such as konjac glucomannan. Suitable food products are those with thickened and/or stabilized (but not gelled) emulsions and the examples include ice cream, whipping cream, meringues, cheese spreads, cheese slices and milk drinks.

U.S. Patent 4,676,976 issued to Toba *et al.* describes a konjac mannan-containing reversible gel that also contains xanthan gum, useful in foodstuffs that are

component of the emulsion composition is preferably present in an amount of from about 1 weight % to about 30 weight %, based on the weight of the emulsion. Since the emulsion compositions may be used as shortening replacements in bakery food product formulations on a one-to-one replacement (by volume) basis, they are very useful for preparing reduced fat versions of traditional full-fat bakery food products.

Another aspect of the present invention is a bakery food product containing the emulsion composition of this invention as a shortening substitute. The emulsion composition is preferably present as a shortening substitute in an amount of from about 5 weight % to about 30 weight %, based on the weight of the bakery product dough or batter prior to baking.

Still another aspect of this invention is a process for preparing an emulsion composition useful as a shortening substitute in bakery applications which has the steps of forming a lipid phase by combining a lipid component with an emulsifier component; forming an aqueous phase by dispersing konjac in water; combining the liquid phase with the aqueous phase under high shear mixing conditions at an elevated temperature to form an emulsion; and cooling the emulsion composition below about 35°C. The konjac is preferably deacylated in this process under alkaline pH conditions, at a pH of about 8 to about 12, such as by introduction of a weak base during the formation of the emulsion. The deacylation is preferably carried out at an elevated temperature, preferably from about 50 °C to about 95 °C. In preferred embodiments of this process, the konjac is partially deacylated, to provide controlled melt characteristics in the emulsion composition that replicate those of the shortening it replaces in bakery food products.

Detailed Description of the Preferred Embodiments

The emulsion composition of this invention has an aqueous phase containing konjac as a gelling agent, optionally in combination with microcrystalline cellulose or a hydrocolloid gum, and a lipid phase containing one or more lipids and emulsifiers.

hydrolysis reaction) is generally carried out by treating the konjac with a weak base or alkali, optionally and preferably at an elevated temperature, *e.g.*, 50-95°C, to enhance the rate of the deacylation reaction.

While not wishing to be bound by any particular theory or mechanism, the inventors believe that the deacylation treatment removes or cleaves at least some of the acetyl groups on the glucomannan polymer, resulting in a konjac that is very useful for preparing melt-controllable gels. As the degree of deacylation is increased, the gels made from such konjac tend to exhibit increased melting points, which is the basis for their being characterized as melt-controllable. Konjac that has been completely or substantially deacylated is useful in making heat stable aqueous gel systems that retain their integrity and do not melt at elevated temperatures generally encountered in food processing operations, *e.g.*, baking, frying, retorting, sterilizing or the like.

The degree of deacylation for konjac treated under alkaline conditions is normally controlled through the selection of pH, reaction time and reaction temperature. The actual degree of deacylation is generally determined by measurement of the gel melting temperature of the alkali-treated konjac, for a given strength aqueous konjac gel. This procedure may be used to determine the appropriate pH (usually controlled by the weak base selection and its concentration), treatment time, and treatment temperature to obtain a konjac gel system with specific melt characteristics. As will be evident to one skilled in the art from the disclosures herein, there are many possible combinations of these parameters that may be employed in deacylating konjac to yield a (partially) deacylated konjac with specific melt temperature characteristics.

The deacylation of konjac is desirably carried out at an elevated temperature, preferably from about 50°C to about 95°C. The pH should be mildly to moderately alkaline, with pH values above about 8 up to about 12 being preferred. More preferably, the pH during the deacylation reaction should be maintained below about 10. It has been found that treating konjac at a pH of about 8.7 at 80°C for about ninety minutes will provide a konjac gel that is partially deacylated.

potassium succinate, lactate, acetate, benzoate, citrate and the like. In systems where MCC or CMC are present, particularly oil-in-water emulsion systems, the use of divalent cations such as calcium is preferably avoided since such divalent cations can adversely affect the stabilization characteristics typically provided by MCC or CMC.

The weak bases described above are typically employed as 0.5-1 % aqueous solutions, where partial deacylation of the konjac is the objective. For complete deacylation, a 2 % solution of a moderately alkaline base such as TSPP is usually sufficient.

Another approach for obtaining controlled melt characteristics in the emulsion compositions of this invention is to increase the time the gel is exposed to high shear mixing conditions during its initial formation in the emulsion. Continued shearing of the konjac gel system interrupts the gel network or matrix as it is being formed, resulting in a fragmented or weaker gel that typically exhibits a lowered melt temperature.

The presence of the konjac in the emulsion compositions of this invention is largely responsible for the controlled melt characteristics of the emulsion. The aqueous phase of the emulsion may, however, contain other water soluble or water dispersible hydrocolloids or functional equivalents of hydrocolloids, *e.g.*, microcrystalline cellulose, in combination with the konjac. Although konjac which has not been deacylated normally increases the viscosity of an aqueous medium but does not form a gel, the presence of one or more other hydrocolloids in addition to the konjac can provide satisfactory gelling characteristics for the system without the need to deacylate the konjac.

Preferred combinations in the aqueous phase of the emulsion compositions are konjac with one or more of the following other water soluble or water dispersible hydrocolloids or functional equivalents of hydrocolloids: xanthan, sodium alginate, locust bean gum, carrageenan, calcium alginate, potassium alginate, propylene glycol alginate, carboxymethylcellulose, methylcellulose, hydroxymethylcellulose, hydroxypropylmethylcellulose, guar gum, karaya gum, gum arabic, starch, pectin,

The emulsions of this invention, in addition to the konjac-containing aqueous phase, also contain a lipid phase with one or more lipids and emulsifiers.

The lipid in the lipid phase may be any fat or oil, including hydrogenated or fractionated versions thereof and including combinations of these lipids. The lipid is desirably a food-grade or food-approved fat or oil, and such lipids include a wide variety of vegetable- or animal-derived lipids that are edible. The lipid may be a solid or semi-solid at ambient temperature, *i.e.*, 20°C-25°C (such lipids are sometimes referred to as a fat, in contradistinction to an oil, which is generally a liquid at ambient temperature). The term "fat" is also used to refer generically to a lipid component of a food product, where the lipid may be either solid, semi-solid or liquid at ambient temperature (*e.g.*, "a bakery product containing a specific level of 'fat'"). The term lipid is generally used in this specification to refer to all lipids, whether solid, semisolid, or liquid, except where the context clearly indicates otherwise.

Suitable lipids for use in the emulsion of this invention include vegetable fats and oils derived from safflower, canola (rapeseed), palm, sunflower, rice, cacao, olive and other plant-derived fats and oils, and include animal fats derived from tallow, lard, whale, fish and other animal-derived sources. Such lipids are typically characterized by having a triglyceride component, which is usually a major component of the lipid. Preferred lipids are those conventionally used in bakery food formulations, *e.g.*, vegetable shortening, since the emulsion composition of this invention facilitates their use at reduced levels, as compared with the amounts used in the original or traditional bakery food product formulations or recipes.

The amount of lipid employed in the emulsion composition depends on the nature and amount of lipid that the emulsion is intended to replace in the bakery food product. An objective in the use of the emulsion compositions of this invention is to provide a reduced level of fat content in bakery food products, where not only a reduction in the fat content but also a reduction in the calorie content from fat may be sought in the reduced fat bakery food product. Consequently, the percentage of fat reduction being sought in the shortening or other lipid being replaced in a specific

emulsifier or emulsifiers that are conventionally included in the bakery food product formulation or recipe. The individual emulsifiers or emulsifier combinations in the emulsifier component may be selected to provide satisfactory mouthfeel, tenderness and staling resistance in the bakery product, as well as to provide satisfactory dough strength and aeration characteristics in the bakery product.

Among emulsifier combinations, satisfactory results are often obtained with at least one emulsifier that is relatively lipophilic and at least one emulsifier that is relatively hydrophilic. Emulsifiers (and other surface active materials) may be characterized as hydrophilic or lipophilic using the well-known hydrophile-lipophile balance (HLB) value. A low HLB value, *e.g.*, less than about 10, indicates lipophilic (or hydrophobic) characteristics, and a high HLB value, *e.g.*, more than about 10, indicates hydrophilic characteristics for the surface active compound being evaluated. For commercially-available emulsifiers, the HLB value of the emulsifier is often included with the product specifications provided by the manufacturer.

The amount of emulsifier or emulsifiers employed depends on the amount of lipid present in the lipid phase, as well as on the amount of lipid phase relative to the aqueous phase in the emulsion composition. The emulsifier is generally employed in an emulsifying-effective amount, to ensure that the lipid phase may be successfully and stably emulsified with the konjac-containing aqueous phase. The emulsifier component is preferably present in the emulsion in an amount of about 1 weight % to about 25 weight %, more preferably about 3 weight % to about 15 weight %, based on the weight of the emulsion. As the amount of lipid in the emulsion formulation is decreased, the proportion of emulsifier component in the lipid phase is normally increased, to compensate in part for the reduced level of lipid in the emulsion and to ensure that a stable emulsion is formed.

The emulsions of this invention preferably have a ratio of aqueous phase to lipid phase within the range of about 1.5:1 to about 19:1 aqueous phase to lipid phase, more preferably, about 2:1 to about 10:1 aqueous phase to lipid phase, all based on weight.

in water. The liquid phase is then combined with the aqueous phase under high shear mixing conditions at an elevated temperature to form an emulsion. The emulsion composition thus formed is cooled below about 35°C. The formation of the emulsion is generally accomplished with high shear mixing devices or a homogenizer. This step is preferably carried out an elevated temperature, from about 50°C to about 90°C.

The formation of the aqueous phase containing the konjac is preferably carried out at an elevated temperature, preferably above about 50°C, to promote dispersion, hydration and gel formation of the konjac, as well as any other hydrocolloids that may optionally be present. The formation of the lipid phase is generally and preferably carried out at an elevated temperature, preferably from about 40°C to about 90°C, to promote melting of the fats employed as lipids and to promote good dispersion of the emulsifiers in the lipid component with the fats and/or oils in such lipid component.

Deacylation of the konjac is preferably carried out during the formation of the emulsion, by adjusting the pH of the konjac-containing phase to an alkaline pH value, preferably at a pH of about 8 to about 12, and more preferably less than about 10. The deacylation of the konjac is preferably carried out at a temperature of from about 50 °C to about 95 °C. The deacylation reaction conditions are preferably controlled to provide a konjac gel in which the konjac is partially deacylated. One preferred procedure for obtaining good control of the deacylation reaction, to ensure only partial deacylation of the konjac by precise control of the pH, is through the introduction of a weak base, as a water-in-oil emulsion, to the konjac-containing emulsion prior to cooling of the konjac-containing emulsion. This approach is described in more detail in the Examples below.

The emulsion compositions of this invention are useful for preparing reduced fat bakery food products as well as essentially no fat bakery food products, as compared with the original or traditional high fat versions of such products.

The controlled melt characteristics of the emulsion contribute benefits to baked food products in which the emulsion composition is employed, in much the

gums, *e.g.*, xanthan gum and guar gum, that are often added as fat replacers and water binding agents in prior art reduced fat baked food products. The emulsion compositions of this invention also provide lubricity in baked food products, and this property contributes to a firm bite mouth feel, along with desirable oiliness instead of sogginess in the baked food product.

A significant advantage of the emulsion compositions of this invention is that they can replace shortening and other conventional fats (lipids) in bakery food formulations on a one-to-one volume basis. Typical bakery food products may contain the emulsion compositions of this invention as a shortening substitute, in amounts of from about 5 weight % to about 30 weight %, based on the weight of the bakery product dough or batter prior to baking. This benefit permits the direct use of the emulsion compositions in the traditional bakery food formulations or recipes, without any modifications being required in the amounts of shortening or in the addition procedure originally called for. The emulsion compositions also provide similar viscosity characteristics in the batter or dough in which they are incorporated as shortening or butter (or other lipid) substitutes.

Still another benefit of the emulsion compositions described in this specification is that they may be readily prepared without the need for specialized equipment. This aspect permits the emulsion to be prepared in a commercial bakery, using conventional mixing equipment normally used in commercial bakery operations.

Use of the emulsion compositions of this invention to obtain reduced fat versions of traditional high fat bakery food products also has the desirable result of producing a reduced fat bakery food product with satisfactory taste and texture characteristics. The bakery products suitable for use with the emulsion compositions of this invention include cakes, pie crusts, Danish pastry, croissants, breads, doughnuts, cookies, snack cakes and the like.

All of these characteristics of the emulsion compositions are highly desirable since traditional bakery product formulations may continue to be used without

At this point, the weak base solution is added with continued high shear mixing. After the addition of the weak base is complete, the emulsion is maintained at 70°C for thirty minutes during which time it is slowly stirred. The emulsion is then allowed to cool to ambient temperature, about 20°C-25°C. During this cooling period the emulsion is repeatedly and mildly sheared for a short period at intervals of two or three minutes until a plastic consistency is attained. The resulting emulsion is firm and plastic, melting between 55°C and 70°C. Upon cooling, the emulsion regains its firm, plastic solid form and exhibits a consistency similar to lard.

This emulsion may be used to replace completely the solid shortening normally used in preparing pie crust; the fat content of the resultant pie crust is thereby reduced to 25% of the fat present in a pie crust prepared from common shortenings, for example, lard or Crisco® vegetable shortening.

Example 2

Example 2 describes the preparation of a water-in-oil emulsion according to this invention, useful as a shortening replacement in Danish pastry. The konjac-containing emulsion of this Example contains about 25 weight % fat and is prepared by the following procedure.

A lipid phase is prepared by heating at 70°C, with stirring to promote melting, the following ingredients in a 600 mL beaker: 89 g butter oil (Level Valley Dairy), and the following emulsifier component: 7 g Dimodan® LSK distilled monoglyceride (Grindsted Products, Inc., Industrial Park, Kansas), 2 grams of Triodan® R90 polyglycerol polyricinoleate (Grindsted Products, Inc.), and 2 g Dimodan® CPK distilled highly saturated monoglyceride (Grindsted Products, Inc.) A one-phase liquid lipid phase results.

An aqueous phase is prepared by dispersing 8 g konjac flour in 192 g distilled water, using a Silverson® mixer at 4500 rpm for a period of one minute, and the aqueous phase is heated to 70°C. A weak base solution of 1 g tetrasodium pyrophosphate in 99 g distilled water is also prepared and is also heated to 70°C, for use as described below.

Company), 10 g Paramount® B hydrogenated palm kernel oil (Van den Bergh Co., Lisle, Illinois), and the following emulsifier component: 30 g Dimodan® OK distilled monoglyceride (Grindsted Products, Inc., Industrial Park, Kansas) and 10 g Tween® 60 polysorbate 60 (ICI Inc., Wilmington, Delaware). A one-phase liquid lipid phase results.

A weak base solution of 1 g potassium citrate in 99 g distilled water is prepared and is also heated to 70°C. The weak base solution is then slowly added to the heated lipid phase, which is mixed at high shear, with a Lightnin® mixer at 3000 rpm. The water-in-oil emulsion that forms is stirred constantly and maintained at a temperature of 70°C during the preparation of the konjac-containing aqueous phase.

An aqueous phase is prepared by dispersing 6 g konjac flour in 294 g distilled water, using a Silverson® mixer at 4500 rpm for a period of one minute, and the aqueous phase is heated to 70°C.

The water-in-oil emulsion of the lipid phase and weak base is then introduced into the konjac-containing aqueous phase, and the multi-phase mixture is then mixed at high shear, with a Silverson® mixer at 4500 rpm for 45 seconds. Upon completion of this addition and mixing, the resulting oil-in-water emulsion is maintained at a temperature of 70°C for thirty minutes. The emulsion is then allowed to cool to ambient temperature, about 20°C-25°C, overnight.

The resulting oil-in-water emulsion is very fine and is a viscous gel. At a temperature of 70 °C, the emulsion does not flow, but the emulsion flows at 85 °C when placed on an incline. The emulsion is refrigerated until ready to be used to bake a yellow cake with only 25 % of the fat content of a traditional yellow cake prepared with full-fat shortening, as described in Example 8.

Example 4

Example 4 describes the preparation of a oil-in-water emulsion according to this invention, useful as a shortening replacement in pound cake with firm but moist texture. The konjac-containing oil-in-water emulsion of this Example is prepared by

A pound cake baked with this emulsion composition contains only 25 % of the fat content of a traditional pound cake prepared with full-fat shortening. The resulting pound cake is characterized as having high volume, fine and firm texture, and possessing a moist and creamy mouthfeel upon mastication. The reduced fat pound cake may be described as being comparable in eating characteristics to a traditional full fat pound cake.

Example 5

Example 5 describes the preparation of a oil-in-water emulsion according to this invention, useful as a shortening replacement in yellow cake. The konjac-containing emulsion of this Example contains only about 10 weight % fat and is prepared by the following procedure, which is similar to the two step approach described for Examples 3 and 4.

A lipid phase is prepared by heating at 70°C, with stirring to promote melting, the following ingredients in a 600 mL beaker: 25 g Crisco® vegetable shortening (Procter & Gamble Company, Cincinnati, Ohio) and the following emulsifier component: 20 g Dimodan® OK distilled monoglyceride (Grindsted Products, Inc., Industrial Park, Kansas), 10 g Tween® 80 polysorbate 80 (ICI Inc., Wilmington, Delaware), 2 g Triodan® R90 polyglycerol polyricinoleate (Grindsted Products, Inc.) and 2 g lecithin. A one-phase liquid lipid phase results.

A weak base solution of 0.5 g tetrasodium pyrophosphate in 99.5 g distilled water is prepared and is also heated to 70°C. The weak base solution is then slowly added to the heated lipid phase, which is mixed at high shear, with a Lightnin® mixer at 3000 rpm. The water-in-oil emulsion that forms is stirred constantly and maintained at a temperature of 70°C during the preparation of the konjac-containing aqueous phase.

An aqueous phase is prepared by dispersing 10 g of a blend of konjac and xanthan, in a weight ratio of about 35:65 konjac to xanthan, in 490 g distilled water, using a Silverson® mixer at 4500 rpm for a period of one minute, and the aqueous phase is heated to 70°C.

choline lecithin (Lucas Meyer, Inc., Decatur, Illinois). A one-phase liquid lipid phase results.

A water-in-oil emulsion is next prepared with a weak base solution, as follows. A weak base solution of 1 g tetrasodium pyrophosphate in 99 g distilled water is prepared and is heated to 50°C. A lipid phase is prepared by mixing 49 g soybean oil and 1 g Admul® WOL emulsifier (Quest International, Zwijndrecht, Netherlands), and this is also heated to 50°C. The weak base solution is then added to the lipid phase, which is mixed at high shear, with a Lightnin® mixer at 3000 rpm. The water-in-oil emulsion that forms is maintained at a temperature of 50°C during the preparation of the konjac-containing aqueous phase.

An aqueous phase is prepared by dispersing 5 g of a blend of konjac and xanthan, in a weight ratio of about 35:65 konjac to xanthan, in 344 g distilled water, using a Silverson® mixer at 4500 rpm for a period of one minute, and the aqueous phase is heated to 70°C.

The lipid phase is then introduced into the konjac-containing aqueous phase, and the multi-phase mixture is then mixed at high shear, with a Silverson® mixer at 4500 rpm for 45 seconds. Upon completion of this addition and mixing, the water-in-oil emulsion containing the weak base is also introduced into the oil-in-water emulsion with high shear mixing, using a Silverson® mixer at 4500 rpm for a period of one minute.

The resulting oil-in-water emulsion is maintained at a temperature of 70°C for twenty minutes. The emulsion is then allowed to cool to ambient temperature, about 20°C-25°C, over a twenty-four hour period.

The resulting oil-in-water emulsion may be used to replace the shortening in bread dough formulations, where the fat content is thereby reduced by more than 80%. The emulsion composition, as noted above, contains an alloy of konjac and xanthan, and this combination of hydrocolloids contributes to dough strength. The emulsion composition also results in finer, more efficient dispersion of the emulsifiers, lecithin and succinylated monoglycerides, in the dough.

water even when the emulsion is processed in a bakery product at elevated temperatures. Emulsion compositions such as described in this Example are useful where a predominantly liquid unsaturated fat is to be used in place of a saturated fat in a bakery food product formulation.

The emulsion composition is desirably used in cake formulations in combination with another hydrocolloid gum, such as a konjac/xanthan alloy which is a good film-former, and the hydrocolloid gum should be incorporated with the dry cake ingredients. A cake prepared in this manner with the pourable emulsion composition will possess high lubricity and other sensory characteristics of a full-fat cake, despite having only 25% of the fat content of a full-fat cake.

Example 8

This Example 8 describes five different emulsion compositions of this invention and their use in a standard yellow layer cake formulation. Four of the emulsions (8A, 8B, 8C and 8E) are oil-in-water emulsions prepared as described in Example 3, and one emulsion (8D) is a water-in-oil emulsion prepared as described in Example 7. Four of the emulsion compositions (8A, 8B, 8C and 8D) are used to replace full-fat shortening in a yellow cake formulation containing 25 % fat content, so that the resultant reduced fat yellow cakes contain just 6.25 % fat content, only 25 % of the fat in the original full-fat cake formulation. One emulsion composition (8E) has half the fat content of the other four emulsions, so that the resultant reduced fat yellow cake contains only about 3 % fat content.

The standard yellow layer cake, "a full-fat cake" containing 25% fat, is prepared using the following standard recipe developed by the American Institute of Baking, Manhattan, Kansas. The amounts shown produce 1000 grams of batter and are proportionately reduced from the amounts provided by the American Institute of Baking which result in 1630 grams of batter. The recipe follows:

Weight (grams)	Ingredient
245	Cake flour
295	Granulated sugar
24.5	Whole egg solids

Table 1

Formulation	8A	8B	8C	8D	8E
Ingredients	Weight (grams)				
Konjac:					
konjac flour[a]	6	6	4	3	
konjac/xanthan blend[b]					6
Emulsifiers:					
Dimodan® OK[c]	30	30	10		
Myverol® P06[d]	5	5			
Triodan® R90[e]	2	2		1.5	
Lipodan®[f]			10		
Dimodan® LSK[g]			5		25
Tween® 60[h]			10		
Sugar ester 290[i]				1	
Soya lecithin[j]				3	
Tween® 80[k]					10
Lipids:					
Soybean oil	30	30		94.5	
Crisco®[l]	33	33	40		15
Krystal Gold®[m]			25		
Weak bases:					
Potassium citrate	2		4		
Tetrasodium pyrophosphate		10		1	
Sodium acetate					2
Water	290	284	292	296	342
Preparation Example	3	3	3	7	3
Type of emulsion	O/W	O/W	O/W	W/O	O/W
Percent deacylated	~30	100	~60	100	~75
Percent fat in emulsion	25	25	25	25	12.5

a konjac flour

b konjac flour blended with xanthan gum in a respective weight ratio of 35:65

c Dimodan® OK distilled monoglycerides from Grindsted Products, Inc.

Table 2

Cake Example	8A	8B	8C	8D	8E
Ingredients			Weight (grams)		
Cake Flour	265	265	265	265	265
Granulated sugar	316	316	316	316	316
Whole egg solids	24	24	24	24	24
Non-fat dry milk solids	18.4	18.4	18.4	18.4	18.4
Salt	7.4	7.4	7.4	7.4	7.4
Baking powder	15.3	15.3	15.3	15.3	15.3
Water (part 1 of 3)	125	125	125	125	125
Flavoring	1.2	1.2	1.2	1.2	1.2
Liquid Egg Color	0.6	0.6	0.6	0.6	0.6
Water (part 2 of 3)	38	38	38	38	38
Water (part 3 of 3)	80	80	80	80	80
Emulsion	120	120	120	120	120
Emulsion Example No.	8A	8B	8C	8D	8E
Cake properties					
Center height (cm)	5.2	4.2	4.8	4.9	4.7
Edge height (cm)	3.0	2.3	3.4	3.3	3.6
Cell size (mm)	0.4-0.5	0.5-1.0	0.5-0.7	0.5-0.7	0.5-0.7

Cake 8A contains the same amount of fat as cake 9A (see Comparative Example 9 below), but it has superior mouthfeel and lubricity and is firmer, giving a clean bite. The finished batter prior to baking is viscous with a density of 0.88 g/cc. Cake 8B has a coarser crumb structure and is dryer than cake 10A. Cake 8C is characterized as being firmer that cake 8A, but this is to be anticipated because its higher solid fat content. Cake 8C has greater lubricity than cake 9A and a firmer bite than cakes 8A and 8B. Cake 8D has a clean bite and lacks gumminess. It is as moist as cake 8A and is comparable in eating quality to cake 8A. Cake 8E has a fine

Table 3

Cake Ingredients	Comparative 9A	Comparative 9B	Standard Cake (Example 8)
	Weight (grams)		
Cake flour	265	277	245
Granulated sugar	316	327	295
Whole egg solids	24.5	24.5	24.5
Non-fat dry milk	18.4	18.4	18.4
Salt	7.4	7.4	7.4
Baking powder (Fleishmann)	15.3	15.3	15.3
Aqueous emulsifier blend	4.1		12.3
Shortening Hi-Ratio	15.3		61.3
Water (part 1 of 3)	153.4	153.4	153.4
Flavoring	1.2	1.2	1.2
Liquid egg color	0.6	0.6	0.6
Water (part 2 of 3)	73.6	73.6	73.6
Water (part 3 of 3)	92	92	92
Xanthan gum	4	4	0
Cake properties			
Fat content	6.25	0	25
Center height (cm)	3.7	3.9	4.5
Edge height (cm)	3.3	3.4	3.7
Cell size (mm)	2-3	large	0.5-0.8

Cake 9A, which has only 25% by weight of the fat compared with the standard cake of Example 8, has a coarse crumb structure with large, uneven voids that are created by moisture channeling. This cake is overly moist and dense and is judged to be barely acceptable. Cake 9B is dense, moist, soggy, and gummy with unusually large air cells and is judged to be totally unacceptable.

11. The composition of claim 1 wherein the lipid component is selected from the group consisting of vegetable fats, vegetable oils, animal fats, animal oils and mixtures thereof.

12. The composition of claim 1 wherein the lipid component is present in an amount of from about 1 weight % to about 30 weight %, based on the weight of the emulsion.

13. The composition of claim 1 wherein the emulsifier component is a combination of emulsifiers.

14. The composition of claim 13 wherein at least one emulsifier has a hydrophile- lipophile balance value of less than about 10 and at least one other emulsifier has a hydrophile-lipophile balance value of greater than about 10.

15. The composition of claim 1 wherein the emulsifier component is present in the emulsion in an amount of from about 1 weight % to about 25 weight, based on the weight of the emulsion.

16. The composition of claim 15 wherein the emulsifier component is selected from the group consisting of mono- and diglycerides of fatty acids, ethoxylated monoglycerides, polyglycerol fatty acid esters, sucrose fatty acid esters, sucrose fatty acid esters esters, sucrose fatty acid esters polyesters, sorbitan fatty acid esters, ethoxylated sorbitan fatty acid esters, and proteinaceous emulsifiers.

17. The composition of claim 1 wherein the internal phase of the emulsion consists of droplets having an average diameter of from about 0.5 μm to about 20 μm.

18. A bakery product containing a shortening substitute which comprises an emulsion composition with an aqueous phase containing water and konjac as a gelling agent; and a lipid phase containing a lipid component and an emulsifier component.

19. The bakery product of claim 18 wherein the emulsion composition is present in an amount of from about 5 weight % to about 30 weight %, based on the weight of the bakery product prior to baking

31. The bakery product of claim 18 wherein the lipid component is present in an amount of from about 1 weight % to about 30 weight %, based on the weight of the emulsion.

32. The bakery product of claim 18 wherein the emulsifier component is a combination of emulsifiers.

33. The bakery product of claim 32 wherein at least one emulsifier has a hydrophile-lipophile balance value of less than about 10 and at least one other emulsifier has a hydrophile-lipophile balance value of greater than about 10.

34. The bakery product of claim 18 wherein the emulsifier component is selected for mouthfeel, tenderness and staling resistance in the bakery product.

35. The bakery product of claim 18 wherein the emulsifier component is selected for dough strength and aeration characteristics in the bakery product.

36. The bakery product of claim 18 wherein the emulsifier component is present in the emulsion in an amount of from about 1 weight % to about 25 weight %, based on the weight of the emulsion.

37. The bakery product of claim 36 wherein the emulsifier component is selected from the group consisting of mono- and diglycerides of fatty acids, ethoxylated monoglycerides, polyglycerol fatty acid esters, sucrose fatty acid esters, sucrose fatty acid esters esters, sucrose fatty acid esters polyesters, sorbitan fatty acid esters, ethoxylated sorbitan fatty acid esters, and proteinaceous emulsifiers.

38. A process for preparing an emulsion composition useful as a shortening substitute in bakery applications which comprises

forming a lipid phase by combining a lipid component with an emulsifier component;

forming an aqueous phase by dispersing konjac in water;

combining the liquid phase with the aqueous phase under high shear mixing conditions at an elevated temperature to form an emulsion; and

cooling the emulsion composition below about 35°C.

39. The process of claim 38 wherein the emulsion that is formed is selected from the group consisting of an oil-in-water emulsion and a water-in-oil emulsion.

53. The process of claim 38 wherein the emulsifier component is present in the emulsion composition in an amount of from about 1 weight % to about 25 weight %, based on the weight of the emulsion.

54. The process of claim 53 wherein the emulsifier component is selected from the group consisting of mono- and diglycerides of fatty acids, ethoxylated monoglycerides, polyglycerol fatty acid esters, sucrose fatty acid esters, sucrose fatty acid polyesters, sorbitan fatty acid esters, ethoxylated sorbitan fatty acid esters, and proteinaceous emulsifiers.

55. The process of claim 38 wherein the konjac is employed in combination with a hydrocolloid or hydrocolloid functional equivalent.

56. The process of claim 55 wherein the hydrocolloid or hydrocolloid functional equivalent is selected from the group consisting of microcrystalline cellulose, xanthan, sodium alginate, locust bean gum, carrageenan, calcium alginate, potassium alginate, propylene glycol alginate, carboxymethylcellulose, methylcellulose, hydroxymethylcellulose, hydroxypropylmethyl cellulose, guar gum, karaya gum, gum arabic, starch, pectin, inulin, maltodextrin and gelatin.

57. The process of claim 55 wherein the konjac and hydrocolloid or hydrocolloid functional equivalent are present together in an amount of from about 0.3 weight % to about 5 weight %, based on the weight of the emulsion.

58. The process of claim 38 wherein the lipid phase and aqueous phase are combined to form the emulsion at a temperature of from about 50°C to about 90°C.

59. The process of claim 38 wherein the emulsion composition has a plastic or solid consistency below a temperature of about 35°C.

60. The process of claim 38 wherein the internal phase of the emulsion composition consists of droplets having an average diameter of from about 0.5 μm to about 20 μm.

61. The process of claim 38 wherein the deacylated konjac provides the emulsion composition with a melting point or flowing point above a temperature of about 60°C.